Future Solar Developments Inc.

Acoustic Assessment Report

Type of Document
Final

Project Name
Acoustic Assessment Report LP9
1572 Story Road, Midhurst, ON

Project Number
WSL-00002250-A0

Prepared By:

exp
561 Bryne Drive, Unit D
Barrie, ON L4N 9Y3
CANADA

Acoustic Assessment Report, LP9

1572 Story Road, Midhurst, ON

Prepared for

Future Solar Developments Inc.

8-3400 Pharmacy Ave.

Scarborough, ON

M1W 3J8

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3 Copies – Future Solar Developments Inc., Scarborough, ON

February 2012

Version Control

Version	Date	Revision Description	Author Initials	Reviewer Initials
1.0	February 16, 2012	Original Report	R.D.	GRJ

Executive Summary

Exp services Inc. (**exp**) was retained by Future Solar Developments Inc. to conduct an acoustic assessment for a proposed solar facility on the site located at 1572 Story Road in Midhurst, located in the Township of Springwater (herein referred to as the "Site"). The assessment was required for a Type 3 solar panel project under O.Reg. 359/09, Renewable Energy Approvals Under Part V.0.1 of the Act as amended by O.Reg. 521/10 and O.Reg. 231/11.

The proposed facility would comprise of a solar panel array, ground mounts for the array, twenty (20) Power One Aurora Uno 5kW inverter to convert Direct Current (DC) energy harvested by the panels to Alternating Current (AC), and one (1) transformer to step-up the power to enable feed into the Hydro One distribution system.

The proposed facility is to be located at 1572 Story Road, Midhurst in the Township of Springwater, Ontario, northeast of the intersection between Story Road, which runs east-west, and Russell Road, which runs north-south. The solar equipment is to be located towards the southwest corner of the property (see Site plans in Appendix A).

The property consists largely of unmanicured land for recreational all-terrain vehicle use, as well as one house used as a private residence. There are neighbouring residential properties located south and east of the site. The property directly north of the site is used as a shooting range and private game retreat, which is forested except for the shooting range.

The noise assessment conducted and reported below was based on MOE guidance documentation ("Basic Comprehensive Certificates of Approval (Air) – User Guide", MOE, 2004). The following summary presents results, conclusions, and recommendations:

Equipment to be operated at the site that has the potential to give rise to environmental noise is limited to twenty (20) inverter units and one (1) transformer. The operation of solar panels does not give rise to environmental noise.

The critical noise receptor has been identified as permanent residences. Point of Reception 1 (POR1) is located approximately 240 m north of the Site on the east side of Russell Road. The reported distance is between the noise sources and the closer of the point of reception property boundary and a point 30 m from the permanent residence.

Potential noise impact from operation of the solar facility on the critical receptors was calculated and assessed versus criteria detailed in MOE NPC-232.

Solar facilities operate during daylight hours. The earliest sunrise at the Site is approximately 5:35 am and the latest sunset is approximately 9:10 pm. As such, it is appropriate to evaluate the project against MOE daytime (07:00 – 19:00), evening (19:00 – 23:00) and nighttime (23:00 – 07:00) hours.

Simultaneous operation of stationary sources results in a calculated maximum noise impact of 21 dBA at POR 1 (residential/agricultural receptor). As the calculated noise impacts are significantly lower than the applicable MOE exclusionary limits of 45 / 40 / 40 dBA for daytime /

evening /nighttime periods respectively, it is concluded that the proposed facility would be in compliance with MOE noise criteria.

This executive summary is a brief summary of the report and should not be used as substitute for reading the report in its entirety.

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List of Appendices

1 Introduction

Exp services Inc. (**exp**) was retained by Future Solar Developments Inc. to prepare an acoustic assessment report (AAR) for a proposed solar facility on the site located at 1572 Story Road, Midhurst in the Township of Springwater (herein referred to as the "Site"). The assessment was required for a Type 3 solar panel project under O.Reg. 359/09, Renewable Energy Approvals Under Part V.0.1 of the Act as amended by O.Reg. 521/10 and O.Reg. 231/11.

The proposed facility would comprise of a solar panel array, ground mounts for the array, twenty (20) Power One Aurora Uno 5kW inverters to convert Direct Current (DC) energy harvested by the panels to Alternating Current (AC), and one (1) transformer to step-up the power to enable feed into the Hydro One distribution system.

The proposed facility is to be located at 1572 Story Road, Midhurst in the Township of Springwater, Ontario, northeast of the intersection between Story Road, which runs east-west, and Russell Road, which runs north-south. The solar equipment is to be located towards the southwest corner of the property (see Site plans in Appendix A).

The proposed project is considered a Type 3 Renewable Energy Project as it would have a maximum name plate capacity greater than 12 kW. The electricity produced by the solar facility is intended to be fed into a local Hydro One distribution line. Equipment to be installed at the facility complies with the Ontario manufactured percentages as required by the Ontario Power Authority's Feed-in-Tariff Program.

This report assesses noise arising from identified sources, details the anticipated impact on the nearest receptors, and evaluates the calculated impact versus MOE criteria.

In accordance with legislative requirements, a copy of this report is to be made available to interested parties including the public and the local municipality at least 60 days prior to the final public consultation meeting.

2 Facility Description

The proposed facility consists of a ground-mounted solar array that will produce electricity from the sun's energy. The direct current generated by the solar array will be converted into alternating current and transformed to enable power to be fed into the Hydro One Network.

The proposed solar array will be attached to mounts on concrete blocks installed in the ground and will occupy an area of approximately 65 by 66 metres. As such the facility represents a fixed system and therefore the array will not produce any noise (c.f. sun tracking arrays). The associated inverter and transformer will be located to the south side of the solar array.

The surrounding land use to the north, east, west, and south is Agricultural (A). A few areas of Environmental Protection (EP) are located northeast and east of the Site. Several zoning maps have been included in Appendix A, as well as Site Plan Aerial maps which show details of the surrounding properties. Zoning maps have been included in Appendix A, as well as Site Plan Aerial maps which show details of the surrounding properties. Given the existing land use and land use in the surrounding area, the project is considered to be in a rural environment. Whilst background sound measurements have not been taken in support of this assessment, the acoustical environment is expected to be dominated by natural sounds. The closest significant road is Highway 400, which is approximately 2 km from LP9.

Solar facilities operate during daylight hours, the earliest sunrise at the Site is approximately 5:35 am and the latest sunset is approximately 9:10 pm. As such, it is appropriate to evaluate the project against MOE daytime (07:00 – 19:00), evening (19:00 – 23:00) and night time (23:00 – 07:00) hours.

3 Noise Source Summary

The locations of all noise sources can be found in the Site Location Aerial Maps (Appendix A).

3.1 Noise Sources

The following noise sources were identified:

- Twenty (20) Power One Aurora Uno 5 kW inverter located south of the farm buildings; and,
- One (1) oil-filled step-up transformer (make and model to be confirmed) located adjacent to the inverter.

The proposed solar array is a fixed system and therefore does not include motors etc. as required with tracking systems.

3.2 Road Traffic

Other than construction traffic, the proposed renewable energy project will result in minimal increase in on-site road traffic associated with servicing / maintenance visits as required. As such visits will be infrequent, road traffic noise associated with the proposed project is considered negligible.

3.3 Technical Information – Sources

Table 1 summarizes the specifications and locations of each significant stationary noise source of the proposed renewable solar energy project:

Table 3.1. Technical Information and Locations of Noise Source

ID	Description	Location	Make	Model #	Rating
I01	Inverter	South of solar panels, 1572 Story Road, Midhurst, ON. Detailed location indicated on map in Appendix A.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I02	Inverter	Inverters are grouped in one location; I02 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I03	Inverter	Inverters are grouped in one location; I03 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW

ID	Description	Location	Make	Model #	Rating
I04	Inverter	Inverters are grouped in one location; I04 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I05	Inverter	Inverters are grouped in one location; I05 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I06	Inverter	Inverters are grouped in one location; I06 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I07	Inverter	Inverters are grouped in one location; I07 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I08	Inverter	Inverters are grouped in one location; I08 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I09	Inverter	Inverters are grouped in one location; I09 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I10	Inverter	Inverters are grouped in one location; I10 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I11	Inverter	Inverters are grouped in one location; I11 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I12	Inverter	Inverters are grouped in one location; I12 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW

ID	Description	Location	Make	Model #	Rating
I13	Inverter	Inverters are grouped in one location; I13 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I14	Inverter	Inverters are grouped in one location; I14 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I15	Inverter	Inverters are grouped in one location; I15 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I16	Inverter	Inverters are grouped in one location; I16 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I17	Inverter	Inverters are grouped in one location; I17 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I18	Inverter	Inverters are grouped in one location; I18 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I19	Inverter	Inverters are grouped in one location; I19 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
I20	Inverter	Inverters are grouped in one location; I20 is located adjacent to I01.	Power One	Aurora Uno PVI-5000-OUTD-US	5 kW
T01	Transformer	Adjacent to inverter	To Be Confirmed	To Be Confirmed	To Be Confirmed

The planned locations of significant noise sources are provided in Appendix A and approximate co-ordinates are provided in Table 5, Appendix B.

4 Points of Reception

Points of Reception for the approval of new sources, including verifying compliance with the Environmental Protection Act, are defined in Publication NPC-205[1] as premises in use, or zoned for future use, as:

- Permanent or seasonal residences;
- Hotels/motels
- Nursing/retirement homes;
- Rental residences;
- Hospitals;
- Camp grounds; and,
- Noise sensitive buildings such as schools and places of worship.

The closest point of reception to the project LP9 is located approximately 240 m from the project. Other receptors are located >500 m from the proposed project location. Below is a description of each point of reception. As per MOE noise guidelines for a Class 3 area, the points of reception have been taken as a point within 30 m of a dwelling or a camping area.

POR1: Located 240 metres south of the project noise sources. It is a residential and agricultural property, with a house and a barn located east of Russell Road. Source to receptor separation distances based on planned equipment locations are provided in Table 3, Appendix B.

5 Assessment Criteria (Performance Limits)

The subject property is located in the Township of Springwater, a rural area (Class 3 Area). Criteria for assessing the impact of noise from stationary sources are provided in the MOE Publication NPC-232 (Sound Level Limits for Stationary Sources in Class 3 Areas (Rural), October 1995, Ministry of the Environment):

NPC-232 Table 232-1: Minimum Values of One Hour L_{eq} or L_{lm} by Time of Day

	One Hour L_{eq} (dBA) or L_{LM} (dBAI)
Time of Day	Class 3 Area
07:00 – 19:00	**45**
19:00 – 23:00	**40**
23:00 – 07:00	**40**

Dependent on day of the year, the facility may generate electricity between 5:35 and 21:10. POR1 is located in a Class 3 area where background noise is anticipated to be dominated by natural sounds. Therefore, the appropriate limits for total equipment operation are the MOE exclusionary limits of 45 dBA / 40 dBA (Class 3 Area, 07:00 – 19:00 (daytime operation) / 19:00 – 7:00 (evening and nighttime operation)).

6 Impact Assessment

Noise produced by the inverters was assessed by using the sound rating given in the manufacturer's specifications for the unit. The manufacturer's specifications for the inverters is provided in Appendix C.

In the absence of a selected make and model number, noise produced by the transformer was assessed based on data published in Table 0.3 of NEMA Standards Publication No. TR 1-1993 (R2000). The transformer size was conservatively assumed to be in the range 101 – 300 kVA (expected size is 100 kVA).

As the noise producing stationary sources at the facility are limited to twenty one (21) pieces of equipment, and twenty of those are grouped together, a simple assessment considering only attenuation due to geometric divergence using procedures detailed in ISO 9613 Part 2 has been conducted. This method of assessment is expected to produce a conservative estimate of noise impact as no consideration is given to attenuation through ground absorption, atmospheric absorption or barrier affects.

The predicted sound levels at the selected PORs due to operation of each noise source are summarized in Table 3 (Appendix B). Distances between each source and POR are also provided in this table.

Sample calculations are provided in Appendix D and an Acoustic Assessment Summary Table is provided as Table 4 in Appendix B.

Consideration of additional solar facilities known to be planned on the same property as LP9 is provided in Section 7.

7 Impact of Known Additional Planned Solar Facilities

Exp has been requested to conduct a noise assessment of an additional proposed solar facility, LP10, also to be located on the property at 1572 Story Road, Midhurst. However, the other solar project, LP10, would be located approximately 500 m away from LP9, and more than 500 m away from POR1. Therefore it can be concluded that the noise resulting from the operation of LP10 would have no significant impact on POR1.

8 Proposed Noise Control Measures

Noise control measures are not necessary for this renewable energy project since the noise resulting from the operation of the solar panels results in a noise level below the MOE exclusionary limits for daytime, evening and nighttime operation.

9 Conclusions

It is concluded that operation of stationary sources associated with proposed Project LP9 at the Site located at 1572 Story Road, Midhurst, in the Township of Springwater, Ontario, would result in noise levels at critical points of reception that are below MOE exclusionary limits for a Class 3 Area.

It is further concluded that, with respect to noise impact, operation of the proposed site would be compatible with existing land use planning guidance.

Simultaneous operation of the facility with the additional planned solar facility for 1572 Story Road, Midhurst would result in noise levels at critical points of reception that are below MOE exclusionary limits for a Class 3 Area.

10 References

1. International Organization for Standardization, ISO 9613-2: *Acoustics – Attenuation of Sound During Propagation Outdoors Part 2: General Method of Calculation, Geneva, Switzerland, 1996.*

2. Ontario Ministry of the Environment, *Publication NPC-232: Sound Level Limits for Stationary Sources in Class 3 Areas (Rural)*, October 1995.

3. Ontario Ministry of the Environment, *Publication NPC-233: Information to be Submitted for Approval of Stationary Sources of Sound*, October 1995.

4. Ontario Ministry of the Environment, *Model Municipal Noise Control by-Law Publication NPC-103*, August 1978.

5. Ontario Ministry of the Environment, *Model Municipal Noise Control By-Law Publication NPC-104*, August 1978.

6. Ontario Ministry of the Environment, Environmental Assessment and Approvals Branch, *Basic Comprehensive Certificates of Approval (Air) User Guide Version 2.0,* April 2004.

11 Limitations

The objective of this report was to assess noise impact from operation of equipment and processes within the context of our contract with respect to existing Regulations and Guidelines within the applicable jurisdiction. Compliance of past and current owners with applicable local, provincial and federal government laws and regulations was not included in our contract for services.

The conclusions of this report are based, in part, on the information provided by others and any testing and analyses described in the report. The possibility remains that unexpected environmental conditions may be encountered. Should such an event occur, **exp** should be notified in order that we may determine if modifications to our conclusions are necessary.

This report has been prepared for the exclusive use of Future Solar Developments Inc. in accordance with accepted environmental study and/or engineering practices for a Noise Study. No other warranties, either expressed or implied, are made as to the professional services provided under the terms of the Survey and included in this report. Any use which a third party makes of this report, or any part hereof, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. **Exp** Services Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Appendix A – Figures

POR UTM Coordinates

ID	Easting	Northing
POR1	600949	4926099

UTM coordinates correspond to points 30 metres away from the residential receptor, as defined in NPC-232

Source UTM Coordinates

ID	Easting	Northing
Inverters (approx.)	600790	4926277
Transformer	600790	4926277

Exp Services Inc.
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(705) 734-6222
exp.

Drawing Title: Site Plan Closest Receptors LP9
Prepared By: Rebecca Orth
Date: February 2012
Project No.: WSL-00002250-00

Acoustic Assessment, LP9
Future Solar Developments Inc.
8-3400 Pharmacy Ave.
Scarborough, Ontario M1W 3J8

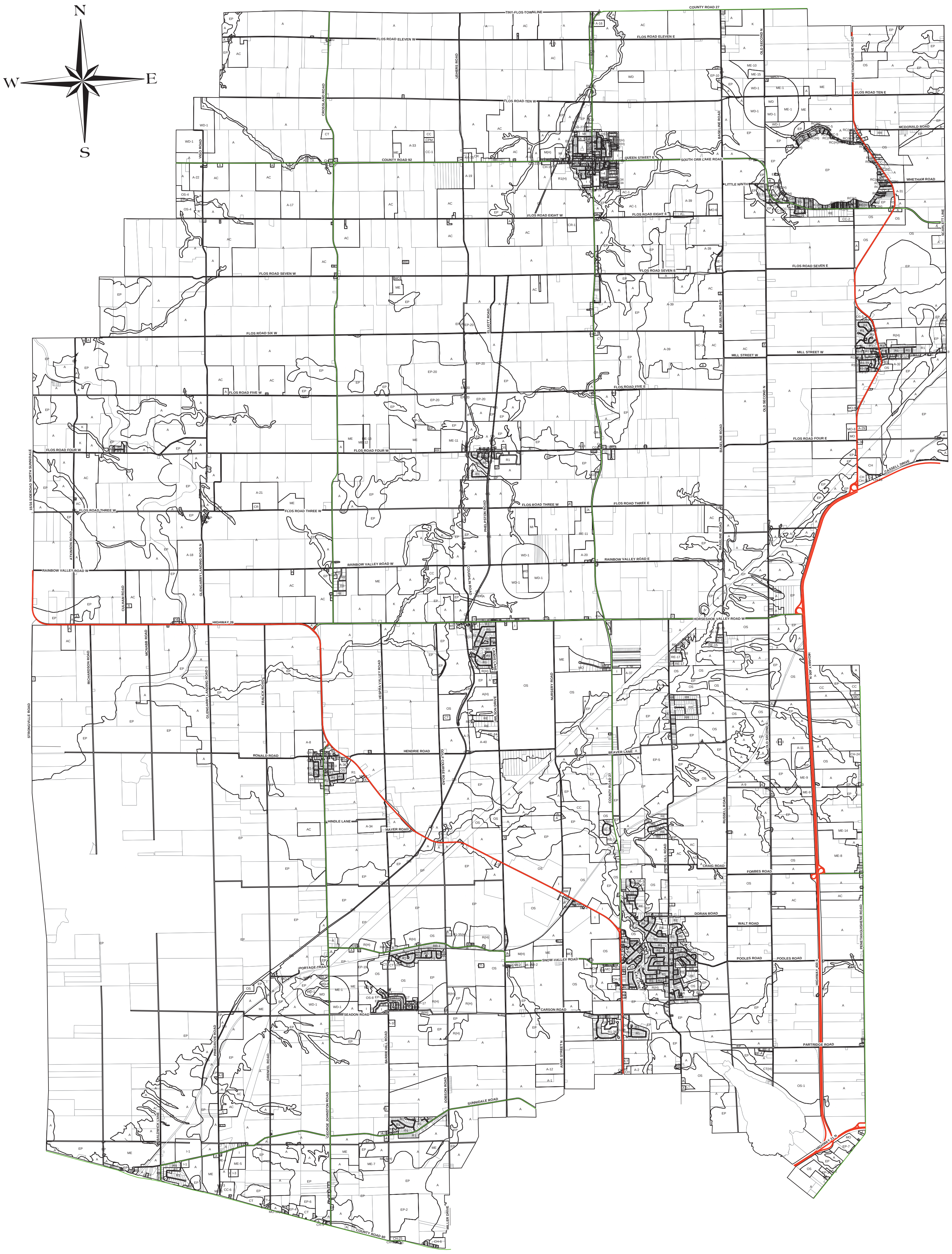
TOWNSHIP OF SPRINGWATER

DETAILED ZONING SCHEDULE 'A'

0 1 2 4 6 8 Kilometers

ZONE LEGEND

R1	Residential
R2	Residential
R3	Residential
RE	Residential Estate
RR	Residential Rural
RS	Residential Seasonal
RC	Residential Conversion
CG	General Commercial
CH	Highway Commercial
CR	Rural Commercial
CT	Tourist & Recreational Commercial
CC	Campground Commercial
CPM	Park Model Trailer Commercial
CA	Adult Entertainment Commercial
K	Kennel
MI	General Industrial/Inside Storage
MO	General Industrial/Outside Storage
ME	Extractive Industrial
WD	Waste Disposal
I	Institutional
OS	Open Space
EP	Environmental Protection
A	Agricultural
AC	Agricultural Consolidation



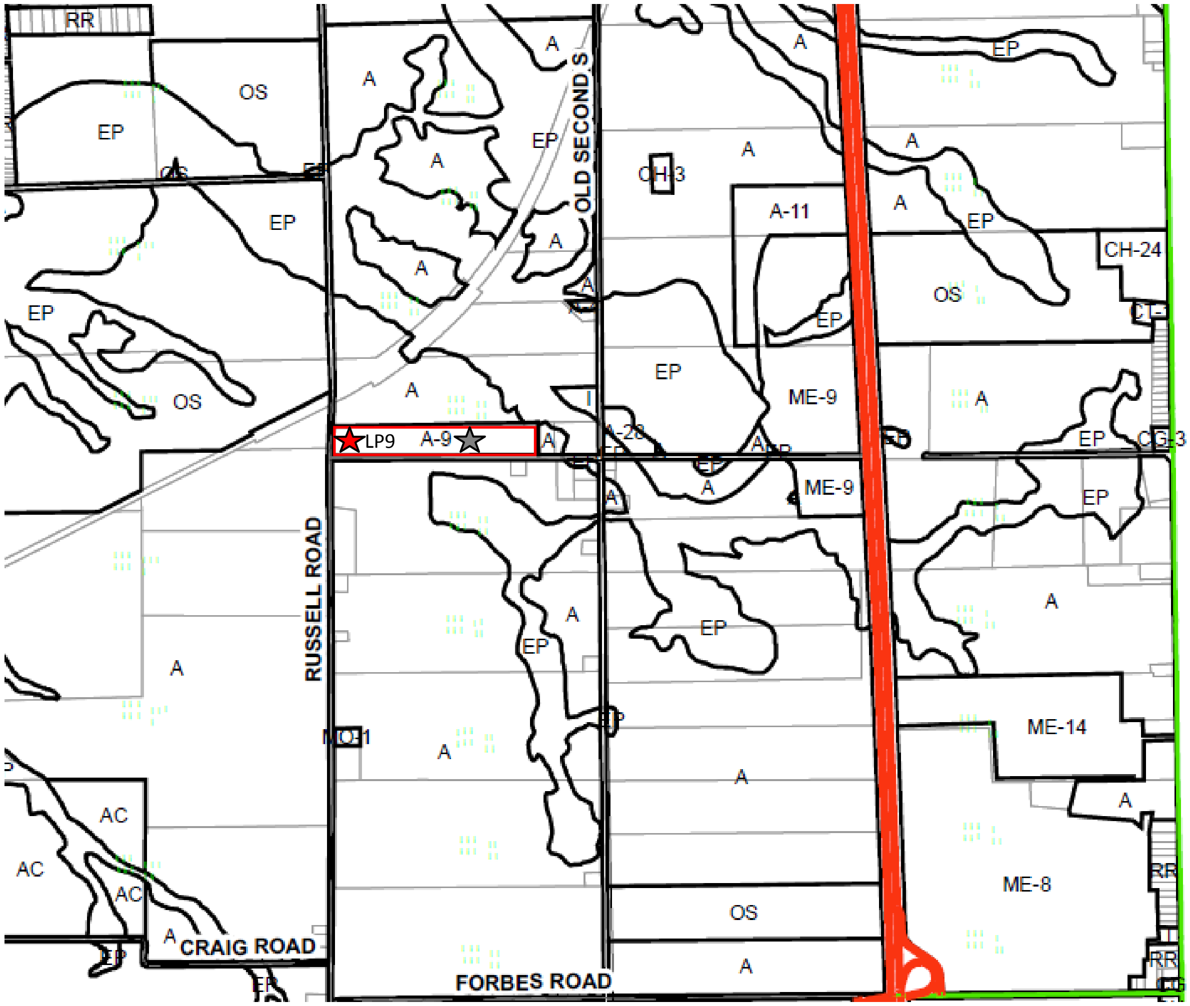
This is Schedule 'A' to By-law 5000-038 passed the 21st day of November, 2005

The Corporation of the Township of Springwater

Deputy Mayor Tony Guergis

Clerk Eleanor J. Rath

Revised October 27, 2005.



A = Agricultural

A-9 = Agricultural

EP = Environmental Protection

★ = location of LP9

★ = location of LP10

Exp Services Inc.
561 Bryne Drive, Barrie, Ontario L4N 9Y3
(705) 734-6222

exp.

Drawing Title: Zoning Map LP9

Prepared By: Rebecca Orth
Date: January 2012
Project No.: WSL-0002250-00

Acoustic Assessment, LP9
Future Solar Developments Inc.
8-3400 Pharmacy Ave.
Scarborough, Ontario M1W 3J8

LP 9 STATISTICS:

NUMBER OF MODULES: 507
NUMBER OF MODULES PER STRING: 13
NUMBER OF STRINGS: 39
PANEL TYPE: CANADIAN SOLAR CS6P-230
FEEDER NAME: F2
CONNECTION VOLTAGE: 4.8Kv

LP 10 STATISTICS:

NUMBER OF MODULES: 507
NUMBER OF MODULES PER STRING: 13
NUMBER OF STRINGS: 39
PANEL TYPE: CANADIAN SOLAR CS6P-230
FEEDER NAME: F2
CONNECTION VOLTAGE: 4.8Kv

DRAFT

KEY PLAN

LEGEND

⊗ POINT OF CONNECTION
PROPERTY LIMIT
APPROX. NVCA REGULATION LIMIT

NOTE:
AERIAL IMAGERY, TOPOGRAPHIC INFORMATION, AND PROPERTY LIMITS SHOWN AS SUPPLIED BY FIRST BASE SOLUTIONS.

NOTES
THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

PRELIMINARY
NOT FOR CONSTRUCTION

NO.	REVISION DESCRIPTION	DATE	BY	APPD

NO.	REVISION DESCRIPTION	DATE	BY	APPD
1	ISSUED FOR ??????	DD/MM/YY	ABC	ABC

SCALE
HORZ 1:1000
VERT 1:50
0 10m 20m 40m

DESIGNED BY

REVIEWED BY

CLIENT
FUTURE SOLAR DEVELOPMENTS INC.
3400 PHARMACY AVE, SCARBOROUGH, ON

exp
exp Services Inc.
The new identity of Trow Associates
• BUILDINGS • EARTH & ENVIRONMENT • ENERGY •
• INDUSTRIAL • INFRASTRUCTURE • SUSTAINABILITY •

BASEPLAN	K.H.
DESIGN	K.H.
CHECKED	G.B.
CAD	K.H.
PROJ. MAN	G.B.
APPROVED	G.B.

PROJECT
FUTURE SOLAR
1572 STORY ROAD, MIDHURST, ON

TITLE
PRELIMINARY SITE PLAN
LP9 & LP10

PROJ. NO.	WSL-2250
SURVEY	FBS
DATE	OCT 7, 2011
DRAWING NO.	SP 5

Appendix B –Tables

Table 1: Noise Summary Table

Source	Sound Power Level (dBA)	Location	Sound Characteristics	Existing Noise Control Measures
Power One Aurora Uno 5kW Inverter	66.0[a]	O	S, T	U
Transformer (liquid filled)	71.0[a]	O	S, T	U

[a] A 5 dB penalty has been applied to these sources as required by the MOE publication NPC 104, and included in the Sound Power Level provided in this table.

Location	Sound Characteristics	Existing Noise Control Measures
O – Outside building	S – Steady	S – Silencer
I – Inside building	QSI – quasi-steady impulsive	A – Acoustic Lining
	I – Impulsive	B – Barrier
	B – Buzzing	L - Lagging
	T – Tonal	E – Enclosure
	C – Cyclic	O – Other
		U – Uncontrolled

Table 2: Performance Limits Summary Table

Point of Reception ID	MOE Designation	Performance Limit (dBA)	
		Day-time	Evening / Night-time
POR1	Class 3	45	40
POR2	Class 3	45	40

Table 3: Point of Reception Noise Impact Table

Source ID	POR1		
	Distance (m)	Sound Level (dBA)	
		Day	Evening/Night
I01	239	7.4	7.4
I02	238	7.5	7.5

Source ID	POR1		
	Distance (m)	Sound Level (dBA)	
		Day	Evening/Night
I03	237	7.5	7.5
I04	237	7.5	7.5
I05	236	7.5	7.5
I06	238	7.5	7.5
I07	237	7.5	7.5
I08	237	7.5	7.5
I09	236	7.5	7.5
I10	235	7.6	7.6
I11	237	7.5	7.5
I12	237	7.5	7.5
I13	236	7.5	7.5
I14	235	7.6	7.6
I15	235	7.6	7.6
I16	236	7.5	7.5
I17	236	7.5	7.5
I18	235	7.6	7.6
I19	234	7.6	7.6
I20	234	7.6	7.6
T01	239	12.4	12.4

Table 4: Acoustic Assessment Summary Table

POR ID	POR Description	Time of Day	Sound Level at POR (dBA)	Verified by Acoustic Audit? (Yes/No)	Performance Limit (dBA) Leq	Compliance with Performance Limit (Yes/No)
POR1	Permanent residence	Day	**21**	No	45	Yes
		Evening/ night	**21**	No	40	Yes

Table 5: Coordinates of Noise Sources and Points of Reception

ID	ETM Coordinates	
	Easting	Northing
I03	600790	4926277
I04	600791	4926277
I05	600792	4926277
I06	600793	4926277
I07	600794	4926277
I08	600790	4926276
I09	600791	4926276
I10	600792	4926276
I11	600793	4926276
I12	600794	4926276
I13	600790	4926275
I14	600791	4926275
I15	600792	4926275
I16	600793	4926275

ID	ETM Coordinates	
	Easting	Northing
I17	600794	4926275
I18	600790	4926274
I19	600791	4926274
I20	600792	4926274
I03	600793	4926274
I04	600794	4926274
T01	600790	4926277
POR1	600949	4926099

Appendix C –Manufacturer’s Data

power-one®
Renewable Energy Solutions

AURORA®

AURORA® UNO

PVI-5000-OUTD-US
PVI-6000-OUTD-US

GENERAL SPECIFICATIONS
OUTDOOR MODELS

Designed for residential and small commercial PV installations, this inverter fills a specific niche in the Aurora product line to cater for those installations producing between 5kW and 20kW.

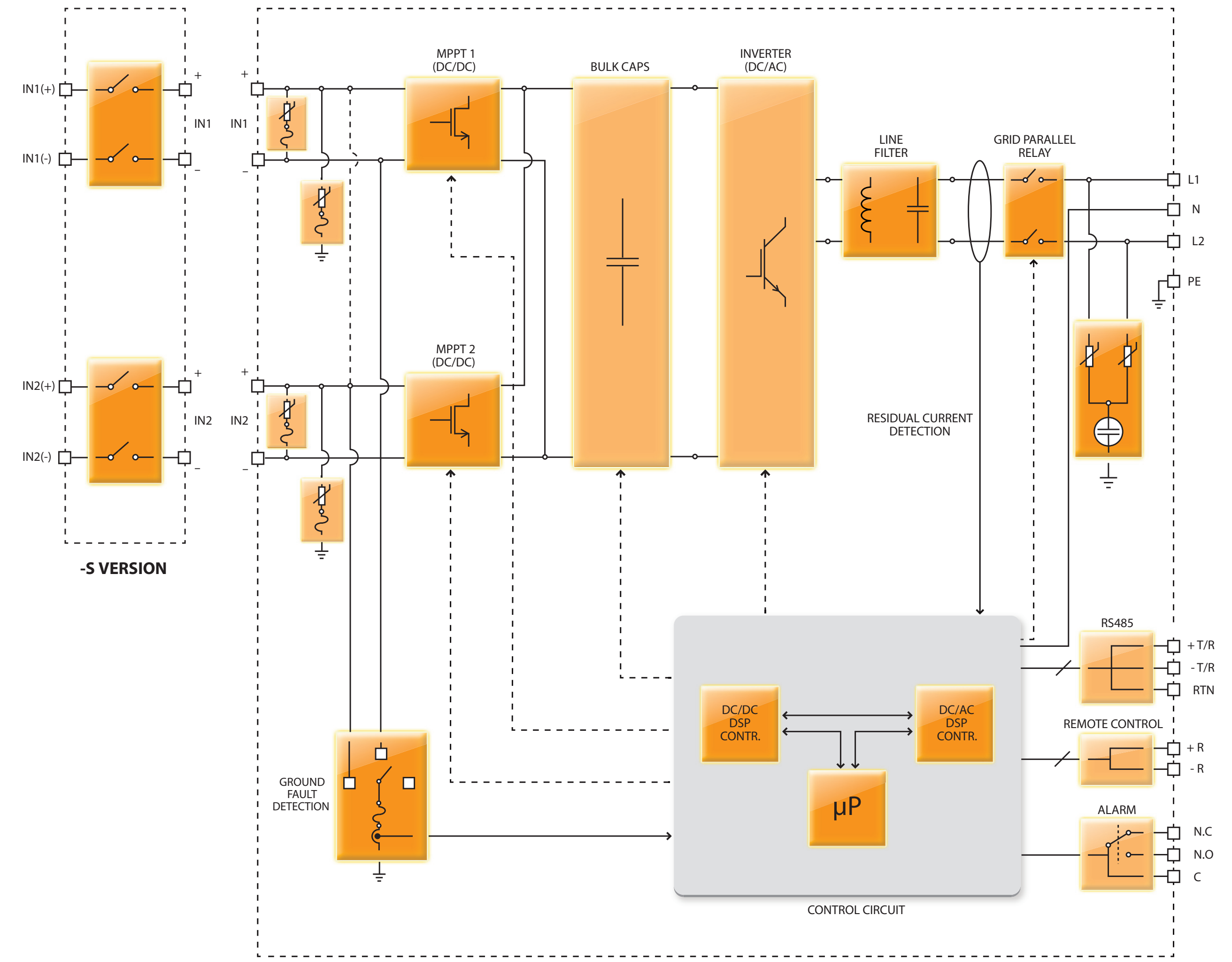
This inverter has all the usual Aurora benefits, including dual input section to process two strings with independent MPPT, high speed and precise MPPT algorithm for real-time power tracking and energy harvesting, as well as transformerless operation for high performance efficiencies of up to 97.1%.

The wide input voltage range makes the inverter suitable to low power installations with reduced string size. This outdoor inverter has been designed as a completely sealed unit to withstand the harshest environmental conditions.

Features

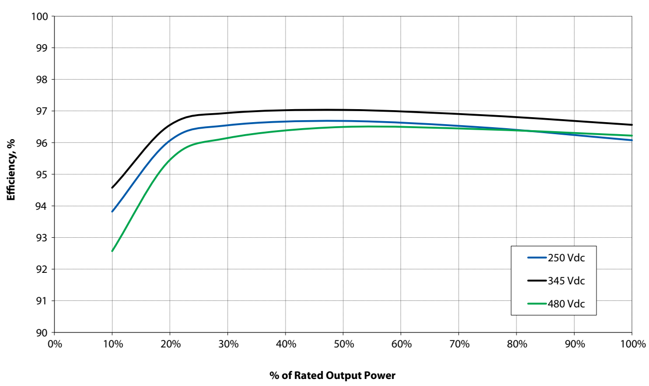
- Each inverter is set on specific grid codes which can be selected in the field
- Single phase output
- Dual input sections with independent MPP tracking, allows optimal energy harvesting from two sub-arrays oriented in different directions
- Wide input range
- High speed and precise MPPT algorithm for real time power tracking and improved energy harvesting
- Flat efficiency curves ensure high efficiency at all output levels ensuring consistent and stable performance across the entire input voltage and output power range
- Outdoor enclosure for unrestricted use under any environmental conditions
- RS-485 communication interface (for connection to laptop or datalogger)
- Compatible with PVI-RADIOMODULE for wireless communication with Aurora PVI-DESKTOP

BLOCK DIAGRAM OF PVI-5000-OUTD AND PVI-6000-OUTD FOR NORTH AMERICA

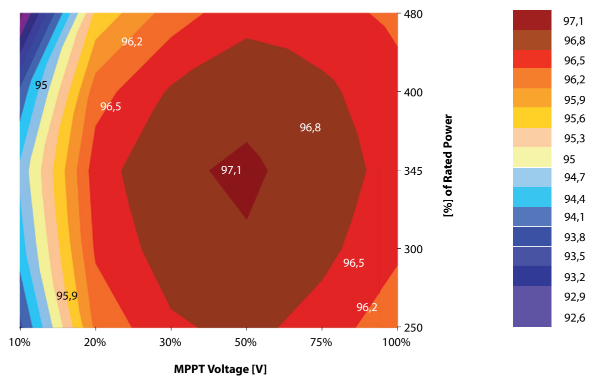


Block Diagram and Efficiency Curves

PVI-6000-OUTD-US



PVI-6000-OUTD-US



PARAMETER	PVI-5000-OUTD-US			PVI-6000-OUTD-US		
Input Side						
Absolute Maximum DC Input Voltage ($V_{max,abs}$)	600 V					
Start-up DC Input Voltage (V_{start})	200 V (adj. 120...350 V)					
Operating DC Input Voltage Range (V_{dcmin}...V_{dcmax})	0.7 x V_{start}...580 V					
Rated DC Input Power (P_{dcr})	5150 W			6180 W		
Number of Independent MPPT	2					
Maximum DC Input Power for each MPPT ($P_{MPPTmax}$)	4000 W					
DC Input Voltage Range with Parallel Configuration of MPPT at P_{acr}	200...530 V					
DC Power Limitation with Parallel Configuration of MPPT	Linear Derating From MAX to Null [530V≤V_{MPPT}≤580V]					
DC Power Limitation for each MPPT with Independent Configuration of MPPT at P_{acr}, max unbalance example	4000 W [225V≤V_{MPPT}≤530V] the other channel: P_{dcr} -4000W [90V≤V_{MPPT}≤530V]			4000 W [230V≤V_{MPPT}≤530V] the other channel: P_{dcr} -4000W [120V≤V_{MPPT}≤530V]		
Maximum DC Input Current (I_{dcmax}) / for each MPPT ($I_{MPPTmax}$)	36.0 A / 18.0 A					
Maximum Input Short Circuit Current for each MPPT	22.0 A					
Number of DC Inputs Pairs for each MPPT	1					
DC Connection Type	Screw Terminal Block, 3 Knock-Outs: 1 ½" or 1" (w/ Ring Reducer)					
Input Protection						
Reverse Polarity protection	Yes, from limited current source					
Input Over Voltage Protection for each MPPT - Varistor	2					
Photovoltaic Array Isolation Control	GFDI (for use with either Positive or Negative Grounded Arrays)					
DC Switch Rating for each MPPT (-S Version)	25 A / 600 V					
Output Side	208 V	240 V	277 V	208 V	240 V	277 V
AC Grid Connection Type	Single phase / Split phase					
Rated AC Power (P_{acr})	5000 W			6000 W		
Maximum AC Output Power (P_{acmax})	5000 W			6000 W		
Rated AC Grid Voltage ($V_{ac,r}$)	208 V	240 V	277 V	208 V	240 V	277 V
AC Voltage Range	183...228 V	211...264 V	244...304 V	183...228 V	211...264 V	244...304 V
Maximum AC Output Current ($I_{ac,max}$)	27.0 A	23.0 A	20.0 A	30.0 A	28.0 A	24.0 A
Rated Output Frequency (f_r)	60 Hz					
Output Frequency Range (f_{min}...f_{max})	59.3...60.5 Hz					
Nominal Power Factor (Cosphi$_{ac,r}$)	> 0.995					
Total Current Harmonic Distortion	< 2%					
AC Connection Type	Screw terminal block					
Output Protection	208 V	240 V	277 V	208 V	240 V	277 V
Anti-Islanding Protection	According to UL 1741/IEE1547					
Maximum AC Overcurrent Protection	35.0 A	30.0 A	25.0 A	40.0 A	35.0 A	30.0 A
Output Overvoltage Protection - Varistor	2 (L1 - L2 / L1 - PE)					
Operating Performance	208 V	240 V	277 V	208 V	240 V	277 V
Maximum Efficiency (η_{max})	97.1%			97.1%		
Weighted Efficiency (EURO/CEC)	96.0%	96.5%	96.5%	96.0%	96.5%	96.5%
Feed In Power Threshold	20.0 W					
Stand-by Consumption	< 8.0 W					
Communication						
Wired Local Monitoring	PVI-USB-RS485_232 (opt.), PVI-DESKTOP (opt.)					
Remote Monitoring	PVI-AEC-EVO (opt.), AURORA-UNIVERSAL (opt.)					
Wireless Local Monitoring	PVI-DESKTOP (opt.) with PVI-RADIOMODULE (opt.)					
User Interface	16 characters x 2 lines LCD display					
Environmental						
Ambient Temperature Range	-25...+60°C (-13...+ 140°F) with derating above 50°C (122°F)					
Relative Humidity	0...100% condensing					
Noise Emission	<50 db(A) @ 1 m					
Maximum Operating Altitude without Derating	2000 m / 6560 ft					
Physical						
Environmental Protection Rating	IP 65					
Cooling	Natural					
Dimension (H x W x D)	1052mm x 325mm x222mmm / 41.4" x 12.8" x 8.7"					
Weight	< 27.0 kg / 59.5 lb					
Mounting System	Wall bracket					
Safety						
Isolation Level	Transformerless					
Marking	cCSAus					
Safety and EMC Standard	UL 1741, CSA - C22.2 N. 107.1-01					
Grid Standard	IEEE 1547					
Available Products Variants						
With DC Switch	PVI-5000-OUTD-US			PVI-6000-OUTD-US		

Ver. 2011-02.2-EN - All products are subject to technical improvements without notice.

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Appendix D –Calculations

Calculation of Sound Power Levels

Inverter

Power One Aurora Uno specifications indicate a sound pressure level of <50 dB(A) at a distance of 1 m. Sound power level for the inverter has been calculated using the following equation:

$L_w = L_p – \log(d_r/d_t) +11$

Where:

L_w = sound power (dBA)

d_r = Reference distance (1 m)

d_t = Test distance

$L_w = 50 – \log(1/1) + 11 = 61$ dB(A)

In the absence of frequency spectra for the inverter it has been assumed that noise from the inverter is tonal and a 5 dB penalty has therefore been applied as required by Section 4 of NPC-104.

Transformer

In the absence of a transformer make and model number, sound pressure has been calculated using data published in NEMA TR 1 – 1993 (R2000) Table 0.3. From Table 0.3, for an immersed (fluid filled) transformer:

Transformer Size	Average Sound Pressure (at ≤1 m)
51 – 100 kVA	51 dB
101 – 300 kVA	55 dB

Anticipated transformer size is 100 kVA, as this size is at the limit of a size range the average sound pressure (at ≤1m) for the next highest size range has been conservatively applied. The sound power level for the transformer has been calculated using the following equation:

$L_w = L_p – \log(d_r/d_t) +11$

Where:

L_w = sound power (dBA)

d_r = Reference distance (1 m)

d_t = Test distance

$L_w = 55 – \log(1/1) + 11 = 66.0$ dB(A)

In the absence of frequency spectra for the inverter it has been assumed that noise from the transformer is tonal and a 5 dB penalty has therefore been applied as required by Section 4 of NPC-104.

Sound Pressure Levels

Sound pressure levels have been calculated conservatively assuming that sound attenuation between the source and the PORs was due solely to geometric divergence (atmospheric absorption, barriers and absorptive ground were not taken into consideration).

The on-site road traffic associated to the renewable energy project will be restricted to occasional visits for maintenance or engineering purposes. As such traffic will be infrequent and so excluded as per Annex to Publication NPC-232 section A.3 (2).

The following equations were employed to calculate sound pressure at points of reception from source power levels including attenuation due to geometric divergence only (from ISO 9613 (Part 2) and to calculate the total sound pressure level at points of reception due to operation of multiple stationary sources:

$$Lp2 = Lp1 + 20\log\left(\frac{r1}{r2}\right)$$

Where:

r1 = distance 1 (reference)

r2 = distance 2 (receptor

Lp1 = Sound pressure level at r1

Lp2 = Sound pressure level at r2

$$L_{tot} = 10\log\left(\sum_{i=1}^{n} antilog\frac{\mathrm{Ln}}{10}\right)$$

Where:

L_{tot} = total sound pressure at POR for all sources

Ln = sound pressure level at POR from source *n*

Example Calculations:

I01 – Inverter is located 239 m from POR1 and generates a sound pressure of <50 dBA at a distance of 1 m (manufacturer's specifications). In the absence of frequency data a penalty of 5 dBA has been applied for possible tonality.

Sound pressure at 1 m = 55 dBA

$$Lp2 = Lp1 - 20\log\left(\frac{d}{do}\right)$$

$$Lp2 = 55 - 20\log\left(\frac{239}{1}\right) = 7.4$$

As each inverter generates the same sound pressure level at 1 m and is approximately the same distance from POR1:

$$L_{tot} = 10\log\left(\sum_{i=1}^{n} antilog\frac{\mathrm{Ln}}{10}\right)$$

$$L_{tot} = 10\log\left(20\left(antilog\frac{7.4}{10}\right) + \ antilog\frac{12.4}{10}\right) = 21$$

Tables 3 and 4 in Appendix B summarize results obtained through application of the above equations.